1982 HAMILTON AIR QUALITY

Ontario

Ministry
of the
Environment

1982 HAMILTON AIR QUALITY

MINISTRY OF THE ENVIRONMENT

TECHNICAL SUPPORT SECTION

WEST CENTRAL REGION

AUGUST 1983

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1. SUMMARY

Due to the economic recession, industrial production in Hamilton compared to previous years, was substantially reduced in 1982 and as a consequence, so were industrial emissions. The improvement on air quality was most notable at the North Park monitoring station on the Beach Strip where concentrations of sulphur dioxide, particulates, and oxides of nitrogen were lower than in previous years. For unknown reasons, levels of total reduced sulphur compounds were slightly higher on average.

In the central part of the city, at the Barton/Sanford station, average levels of sulphur dioxide, particulates, oxides of nitrogen and carbon monoxide were relatively unchanged. The effect of lower industrial emissions seemed to be counter-balanced by a greater frequency of northeast winds and inversion conditions.

The Air Pollution Index reached the advisory level of 32 on 13 occasions compared to 8 in 1981. The month of May showed particularly elevated levels as northeast winds and frequent inversions predominated for over half the time.

The network of high volume samplers measuring suspended particulates showed variable trends. Stations at or below the criterion level had similar concentrations to 1981. Three stations in the vicinity of industry and one in the west end showed increases of 10 to 15 percent while one location - closest to industry - showed a 10 percent improvement.

Dustfall jars located throughout the city to measure heavy settleable dust, showed no significant change from previous years.

Similarly, the network of fluoride monitors did not indicate any reductions in concentrations. With the steel industry considered a significant contributor of this pollutant and in view of the reduced production, improvements had been anticipated but surprisingly did not materialize. One location, in the vicinity of a brick manufacturer did, however, show considerable improvement.

2. INTRODUCTION

The Air Management Program in Ontario is based on controlling man-made emissions to meet ambient air quality objectives, which in turn are based on known effects on health, quality of life or sensitive vegetation, whichever is most stringent. To achieve these objectives, sources of pollution are identified, their emissions evaluated and appropriate control measures are instituted. Ambient air monitoring is then used to verify that the controls have been successful. Monitors are mainly sited in areas suspected of experiencing higher levels of air pollution. If and when these areas achieve acceptable air quality, then other areas should also be acceptable.

3. MONITORING NETWORK

The Ministry of the Environment operates a network of ambient air monitors throughout Hamilton as shown in Figure 1. Monitoring is concentrated in the lower city, that is, the area below the Niagara Escarpment, and the network is centered on two major stations which monitor a variety of pollutants with automated analyzers. The main station, known as 29025 - Barton/Sanford provides the data which forms the basis for the Hamilton Air Pollution Index (API). The other major station is on the Beach Strip and is known as 29008 - North Park, immediately adjacent to the Queen Elizabeth Way. The remainder of the network consists of numerous but less sophisticated monitors. Most of the network has been in existence since at least 1970. Besides this regular network, special surveys are carried out occasionally in order to identify specific problems.

Meteorological data (wind speed and direction and temperature) are observed at station 29026, located on the sewage treatment plant grounds on Woodward Avenue. We consider this location to be more representative of local conditions than the Federal Government's Mount Hope Weather Station due to the complex meteorological patterns which sometimes prevail in Hamilton.

The results of a computer program known as a "pollution rose" will be introduced in this report. The program is essentially a cross-tabulation of hourly pollutant concentrations (measured at the two main stations) by wind speed and direction classes (although only direction classes are given in the report for simplicity). The program is a useful tool in source identification of pollutants. The total annual percentage effect of concentrations originating from a certain wind direction depends of course on the frequency of winds from this direction.

4. ANALYSIS OF DATA

4.1 Air Pollution Index

The Hamilton air pollution index (API) is used as a warning system to alert the public to elevated air pollution levels. It is derived from 24 hour average concentrations of sulphur dioxide and particulate matter as measured at the Barton/Sanford Station. The combination of these two pollutants has been shown to be at least indicative of detrimental human health effects. No action is taken for readings up to 31. At 32, known as the advisory level, and with a forecast of unfavourable dispersion conditions, major point source emitters are notified and asked to voluntarily curtail certain operations. At an API of 50, cutbacks by these sources become mandatory. These levels are set with a considerable safety margin before health effects should take place.

The API station is located at the interface between the heavy industrial and residential areas of the city and about half-way between downtown and the integrated steel mills. It is directly downwind of the industrial area during times of poorest atmospheric dispersion. Due to differences in station locations in relation to local sources, inter-city API comparisons are rather tenuous and therefore, should not be made.

During 1982, there were thirteen instances of the API reaching or exceeding 32 as listed in Table 1, and these were related to three types of meteorological regimes.

Eight of the incidents were related to inversions due to the classical lake breeze phenomenon (No's 1,2,3,4,6,8,12 and 13 in the table) in which cool or cold lake air flowed into the city beneath a warmer air mass from the south trapping urban and industrial emissions close to ground level.

Three other incidents (No's 5, 9 and 10) were related to stagnant high pressure cells which created subsidence inversions. These inversions were widespread and pollutant levels were elevated throughout most of Southern Ontario. Associated with high pressure areas is a downward motion of the

air aloft. This descending air undergoes warming, creating an elevated inversion. These inversions are usually the most prolonged and their durations are dependent on the movement of the high pressure cell. In Hamilton, winds usually must be northeast in order to cause the API to reach 32; however, on October 27, the API exceeded 32 for 21 hours and winds were south to southwesterly. The pollutant buildup was not due to local industries but rather was due mostly to long range transport of pollutants, likely from the United States. A high pressure cell had lingered for three days on that occasion.
The other two incidents (no's 7 and 11) were related to prolonged and widespread northeast winds. Inversions may or may not have been present. In any case, wind shifts cleared the air quickly and the time above 31 was short in both cases.

4.2 Particulates

There are three methods for the measurement of particles, each method relating to a different size range. Dustfall jars measure heavy material, generally greater than 10 microns in diameter (one micron is one-millionth of a metre). High volume samplers measure suspended particulates ranging in size from submicron to 50 microns and co-efficient of haze tape samplers measure mostly fine material - from submicron to about 10 microns.

The ambient air quality objectives for suspended particulate are based on health effects when occuring in combination with sulphur dioxide. As mentioned previously, this combination was proven to be indicative but not necessarily causative of such health effects. The dustfall objectives are based on nuisance effects while soiling index objectives were chosen arbitrarily.

4.2.1 Total Suspended Particulates

A high volume sampler draws a known volume of air through a pre-weighed filter for a 24 hour period (midnight to midnight). The exposed filter is weighed and the difference (weight of solids on filter) in conjunction with the known amount of air flow is expressed as a concentration in

micrograms per cubic meter. At two locations in Hamilton, these devices operate daily. At eleven other locations, they run on a once every sixth day cycle.

The network shows a definite gradient of higher concentrations closer to the industrial area. A comparison with 1981 levels shows variable trends. Stations at or below the criterion level of 60 ug/m^3 yielded results generally similar to 1981. Three stations in the vicinity of industry and one in the west end showed increases of 10 to 15 percent, while one location - closest to the industrial area - showed a similar reduction. It should be noted however, that all results showed marginal improvements relative to 1980 data and that some 1981 averages had dropped to levels lower than expected. The observations for 1982 probably reflect the combined effect of changes in industrial emissions and atmosperic variability.

Pollution roses for suspended particulates were manually calculated for the two main stations by classing the data according to predominant daily wind directions (as opposed to the hourly pollution rose computer program which classes hourly data). Only those days for which a clear predominant direction could be determined were included and rainfall/snowfall days were also excluded (Figures 14 and 15).

Both roses indicate a strong correlationship of high averages with winds from the industrial sector. However, other sectors make significant contributions as well. For instance at North Park the QEW's effect is noted by the high average of 103 ug/m^3 for northwest winds. Although this average is comprised of only four samples, other pollution roses also show peaks for northwest winds. At Barton Street, elevated averages for south and southwest winds (90 and 73 ug/m^3 respectively) indicate an influence by very local sources such as traffic on Barton Street.

Although other sources affect both stations, it is apparent that the industrial area is still the prime source of

particulates, even during a year of substantially reduced emissions.

The hi-vol filters were analysed for seven metals, as well as sulphates and nitrates. The data is tabulated in Table 2c.

Concentrations of nickel, cadmium, lead and vanadium showed very low concentrations which did not vary appreciably throughout the city indicating that these were background levels. The 24 hour criteria for these metals were easily met.

Concentrations of chromium and manganese were somewhat higher and showed a gradient with distance from the industrial area, however, the highest levels were well below acceptable levels.

Iron concentrations were high, and also showed a gradient with distance from the industrial area where concentrations were generally well above guidelines.

The sulphate/nitrate components comprised a large portion of the measured particulate matter. These constituents are largely by-products of major high temperature fuel combustion sources and can travel hundreds of miles from their source. The concentrations in Hamilton are generally uniform with slightly higher levels found in the industrial area, indicating a contribution from local industries. Elevated concentrations at most of the stations (other than North Park) during northeast winds, confirms this. However, most of the city shows levels only slightly higher than other areas in the province including rural areas, indicating that much of this material is imported into the city via long range transport from distant sources. The sulphate/nitrate components are known to be a factor in reduced visibility and are often responsible for the widespread haze observed in Hamilton during southerly winds.

It should be noted that the sulphate/nitrate analyses are prone to error due to the measurement methodology. Atmospheric sulphate data obtained with the high volume sampler/glass fibre filter combination are subject to a positive error which can be substantial. The error is due to the conversion of gaseous sulphur dioxide to particulate sulphate by the filter medium. Various factors affect the conversion rate, but the spurious formation is largest in winter and least in summer.

The nitrate data are also in error to a variable extent due to the occurrence of both positive and negative interferences. The error can be substantial. The positive interference is due to adsorbtion of gaseous nitric acid from the sampled air by the filter medium or, to a lesser extent, oxidation of nitrogen dioxide to nitrate by the filter medium. The negative interference is caused by the reaction of co-collected sulphuric acid with particulate nitrate to release nitric acid.[1]

For the reasons stated above the sulphate and nitrate data presented should be primarily used for evaluation of trends rather than use of the actual values. Alternative methodologies and filters are under investigation to avoid spurious results in future.

McMaster University also continued hi-vol sampling as part of their study on the health effects of air pollution. Their sampling coincided with the Ministry sampling schedule, making their network of 14 hi-vols a useful supplement to ours. The samplers are mostly situated in residential areas on the mountain and far ends of the city and most recorded

1 Environment Canada, Environmental Protection Service, "The Sampling and Analysis of Airborne Sulphate and Nitrates: A Review of Published Work and Synthesis of Available Information", Surveillance Report EPS 5-AP-82-14, Air Pollution Control Directorate, March 1981, p. vii.

very low concentrations, generally within objectives and (Table 2b) similar to 1981 levels. The monitor at Woodward/Brampton returned to more normal levels following a high yearly mean in 1981 which had been due to nearby construction activities.

The large dual network makes it possible to draw a contour map of suspended particulate concentrations, given in Figure 2. It can be seen that the majority of the city meets the yearly objective of 60 ug/m^3. Concentrations are elevated close to the industrial area plus in a small pocket of light manufacturing near Main Street and Highway 403.

The effect of urban activity on suspended particulate concentrations is illustrated by three monitors in the downtown area. All three are in the same general area with respect to the industrial area, but show widely different results. The hi-vol on the roof of City Hall (29007) approximately 200 feet above ground, had a geometric mean of 60 ug/m^3 while only a short distance away near the intersection of James and Hunter (29001), the mean was 67 ug/m^3. This monitor on the roof of the Regional Health Unit is only 30 feet above ground. The difference in concentration between the two stations is probably accounted for by proximity to road traffic. Another short distance away is the Aberdeen monitor whose mean was only 51 ug/m^3, well below the objective. This hi-vol is in a residential area set off from major roadways and the heavy activity of the business district.

A similar observation is noted in the east end of the city. The hi-vol at the Centennial Parkway location showed a mean of 57 ug/m^3 while in a residential area on Pottruff Road, the mean was only 42 ug/m^3. Again, the difference would seem related to road traffic.

4.2.2 Soiling Index (Co-effiecient of Haze)

Co-efficient of haze tape samplers operate continuously and can determine hourly or two-hour average soiling values.

Air is drawn through a filter paper and the optical density of the soiled spot is measured by light transmittance. The one-hour telemetered instruments have readings taken prior to and after sample collection, and resultant light obstruction determined and transmitted on a real time basis to the data bank. Two-hour instruments rely on tape collection, transmittal and readings at some time after the event. The manual handling and methodology involved results in considerable inaccuracy. It has been demonstrated that the two-hour instruments yield values at least 25 percent lower than the one-hour telemetered units and are considered to be less reliable and are not directly comparable. For these reasons data on the two-hour instruments has been omitted from this report.

The main stations on Barton Street and North Park both employ one-hour instruments (Table 3a). North Park showed a huge improvement in its yearly mean falling to just slightly above the objective. As well, the 24-hour objective was exceeded only 23 times compared to 76 times in 1981. The improvement is likely due to a large overall reduction in emissions by local industries. It should be noted that although a substantial decrease in emissions occurred in 1981 from 1980, this was entirely due to the 4 month Stelco strike. Emissions prior to the strike in August were normal and 52 of the excessive daily readings at North Park in 1981 occurred prior to th strike.

In contrast, Barton's yearly average remained unchanged from previous years. Although industrial emissions were lower in 1982 this was probably counterbalanced by a higher than normal frequency of northeast winds and inversion conditions. The number of days above the daily objective actually increased from 24 in 1981 to 41 in 1982. The month of May was particularly noteworthy in that northeast winds occurred 53% of the time and 13 days exceeded the soiling index objective.

Soiling index pollution roses given in Figures 16 and 17 indicate that the industrial area is the prime source of fine

particulates at both stations, ie northeast quadrant winds for Barton and southwest quadrant winds for North Park give the highest averages. Traffic emissions also significantly affect the readings as shown by elevated averages for southeast winds at Barton (from the intersection of Barton and Sanford Streets) and for northwest winds at North Park (exclusively from the highway).

4.2.3 Dustfall

Dustfall is that material which settles out of the atmosphere by gravity, and is collected in plastic containers during a 30 day exposure time. The collected material is weighed and expressed as a deposition rate of grams/square meter/30 days. The significance of observations is restricted to relatively local areas.

Dustfall levels in 1982 (Table 4) remained similar to those of previous years. Figure 3 depicts dustfall isopleths, and shows that a small portion of the lower city and the Beach Strip near the industrial area was encompassed by the 9.0 grams/m^2/30 days contour which represents twice our objective. Conditions in this area, for the most part were quite poor. Only one station on the mountain recorded a mean below the yearly objective of 4.5 grams. The contour of this concentration showed that it encompasses about half of the city. Dustfall levels throughout the city have remained virtually unchanged throughout the 1970's; a puzzling observation considering the considerable reductions in industrial process emissions and the correspondingly large reductions in suspended particulate concentrations noted in Figure 4. Fugitive dust sources such as uncontrolled stock piles, excavation and construction, vehicular emissions, road dust, open lots susceptible to wind erosion, etc. may be important in explaining this observation.

Road traffic is probably a major source of the dust at several of the stations. For example, the North Park station records much higher loadings on average than the jar on

Beach Blvd. (29084) only two blocks away. Road traffic emissions from the Q.E.W. are likely responsible. As well, the jar on Concession Street (29031) at Upper Sherman records higher than expected loadings, probably due to the heavy traffic which passes directly by the station.

On Ottawa Street (29010) the continuing construction of a new hot strip mill at Dofasco has resulted in extremely high concentrations which are probably due to the increased heavy truck traffic and the construction activities themselves. The jar at the base of Strathearn Avenue (29037) is also severely affected by an unpaved, dusty and well travelled path immediately beside the station. This location has recorded extremely high loadings throughout its history, mostly due to this dusty road. The lower loadings in January and December when the ground is frozen or snow-covered attest to this.

4.3 Sulphur Dioxide

Most sulphur dioxide (SO_2) emissions in Hamilton, as detailed by the emissions inventory, stem from industrial sources. Only a small portion is accounted for by fuel burning in domestic space heating. The Barton/Sanford and North Park stations monitor SO_2 continuously and data is summarized in Table 5.

Sulphur dioxide trends from the two stations since 1970 are illustrated in Figure 5. In 1982, as in the past several years, the concentrations were acceptable, within the yearly objective and there were no readings above the hourly or daily objectives. These objectives are based on vegetation damage; a more stringent limitation than human health effects. Similar to the soiling index, North Park showed an improvement from 1981 while Barton showed a slight deterioration for the same reasons stated previously. The pollution roses for the two stations given in Figures 18 and 19 confirm that the industrial area is the prime source of SO_2 in the city.

4.4 Total Reduced Sulphur

This measurement is comprised mostly of hydrogen sulphide (H_2S), the "rotten egg" gas. However, since the analyzer also reacts to other sulphur compounds, the data is referred to as total reduced sulphur (TRS). The objective for hydrogen sulphide may still be applied to the observed values and is based on the odour threshold level. Both Barton/Sanford and North Park monitor this pollutant continuously and the data are summarized in Table 6.

The major sources of hydrogen sulphide and related sulphur compounds are the steel industry's coke ovens, certain slag reclamation processes and under upset conditions, a local manufacturer of carbon black.
The sewage treatment plant is another potential source, of odours but only during certain upset conditions.

Yearly trends for the two stations are illustrated in Figure 6. In 1982 TRS concentrations at Barton were similar to 1981 with 32 exceedences of the hourly objective for H_2S compared to 46 in 1981.

Concentrations at North Park were slightly higher on average than in previous years with 49 exceedences of the hourly H_2S criterion. This is surprising considering the reductions shown for other pollutants and the much lower industrial emissions in 1982.

The incidents of elevated concentrations at the two stations occurred separately and under different circumstances. The Barton incidents usually occurred during very light northeast winds, most often during inversion conditions in the May - August period. The North Park incidents occurred during southwesterly winds, variable wind speeds and occurred randomly throughout the year. Not surprisingly, the TRS pollution roses for the two stations given in Figures 20 and 21 both point strongly towards the industrial area.

4.5 Carbon Monoxide

The major source of carbon monoxide emissions is the automobile. However, in Hamilton there are also some contributions from industry. Due probably to automotive emission controls, the levels measured at Barton Street (Table 7) decreased greatly over the 1970-81 period (Figure 7). In 1982, the levels were similar to the previous few years and were well below the objectives which are based on health effects.

The pollution rose given in Figure 28 indicates that northeast quadrant winds (from industry) and southeast quadrant winds (from the intersection of Barton and Sanford Streets) yield the highest averages.

4.6 Oxides of Nitrogen

The primary source of oxides of nitrogen are high temperature combustion sources including the automobile. The most abundant oxides are nitric oxide (NO) and nitrogen dioxide (NO_2), and they are monitored continuously at both Barton/Sanford and North Park. At each station, a single instrument makes measurements of NO, NO_2 and total nitrogen oxides. Nitric oxide is measured directly, and the total oxides are measured by internally converting all other nitrogen oxides to nitric oxide. The instrument then determines nitrogen dioxide to be the difference between the first two measurements.

Of the three reported pollutants, objectives exist only for nitrogen dioxide and these are based on odour threshold levels (hourly) and health effects (24-hourly). The objectives were not exceeded at either station in 1982.

Data for oxides of nitrogen are given in Tables 8-10, and yearly trends since 1975 are illustrated in Figures 10-12. As with most other pollutants, North Park showed a significant decrease in these pollutants while Barton remained similar to previous years for reasons stated previously.

Pollution roses for the 3 measurements are given in Figures 22-27 and seem to indicate an equal contribution by traffic and industry to the concentrations of these pollutants.

Similar to previous years, NO_2 levels were comparable at the two stations, but NO levels were twice as high at North Park than at Barton. This is probably explained by North Park's proximity to the QEW. Most vehicular emissions of oxides of nitrogen consist of NO which later is oxidized to NO_2 in the atmosphere. Under normal circumstances the North Park station probably monitors the NO before this conversion can fully take place. The pollution rose (Figure 24) confirms this as the highest NO average occurs under northwest winds. (ie. exclusively from the highway).

Oxides of nitrogen are an important factor in the photochemical production of ozone which will be discussed in the next section of this report.

4.7 Ozone

Oxidants are mainly a product of photochemical reactions involving oxides of nitrogen, hydrocarbons and sunlight. Ozone accounts for most of the oxidants produced. The sources of the precursor pollutants are mainly industrial and automotive.

Ozone is known to be associated with many respiratory problems, and at elevated concentrations, people can experience adverse health effects. Ozone is also injurious to different types of vegetation including certain tobacco and tomato crops. The one-hour objective for ozone (.08 ppm) is based on vegetation effects, however, ozone can also have detrimental human health effects at only slightly higher levels.

Ozone concentrations follow very definite annual and daily trends. Highest levels occur during the summer (May - September), and the daily maximums usually occur during mid-afternoon. Both patterns are directly related to temperature and the amount and intensity of sunlight.

Ozone is measured at the Barton Street station, and data is summarized in Table 11 while yearly trends are illustrated in Figure 8.

The 1982 average was similar to 1981 with only 4 exceedences of the hourly objective reflective of the relatively cool summer. The higher concentrations when they occurred, were widespread, occurring concurrently throughout Southern Ontario during periods of southerly or southwesterly winds which implies their origin to be in the United States.

The pollution rose in Figure 29 confirms that highest concentrations occur under winds from the southwest quadrant. However, the peak for these directions is not as pronounced as usual due to the relative absence of high concentration periods during the summer.

Ozone, hydrocarbons and oxides of nitrogen can be transported over great distances and can be augmented by local sources. However, Hamilton and other major urban areas usually experience lower ozone concentration than their more rural surroundings during peak occurrences. In fact, the concentrations in Hamilton are among the lowest recorded in Southern Ontario, probably due to the numerous high temperature combustion sources which produce higher levels of nitric oxide, a scavenger of ozone. Nonetheless, ozone and other oxidants remain a problem which, due to the complexity of their formation and the long range transport phenomenon, will have to be resolved on a regional rather than local scale.

4.8 Fluoridation

This measurement is a crude assessment used to determine relative quantities of various fluoride compounds in the ambient air. A lime coated paper is exposed to the atmosphere for approximately 30 days and is then chemically analyzed for fluoride. The fluoride objectives are based on vegetation damage and for this reason, the objective is more stringent during the

growing season. For the period of April 15 to October 15, it is 40 micrograms/100 square centimeters/30 days while for the remainder of the year it is 80.

In Hamilton, the major fluoride sources are the basic oxygen furnaces used by the major steel industries which require fluorspar as a fluxing agent. In addition to these process emissions, there are other minor sources such as coal burning, since coal contains trace amounts of fluoride. A brick manufacturing plant at the base of the escarpment near Gage Park is the only non-steel industry source.

Data for 1982 is summarized in Table 12 and the yearly trend since 1970 is illustrated in Figure 9.

The trend graph shows that levels have remained relatively stable since 1974 following large reductions in concentrations which began in 1971.

In 1982, consistently elevated concentrations continued to be observed on the Beach Strip (29008 and 29058) and at Burlington/Gage (29059) near the main fluoride sources.

The rest of the stations showed only occasional and marginal exceedences of the objectives. Based on past vegetation studies, it is unlikely that even the highest measured levels have affected local plant life. One station on King Street East near Kenilworth (29062) near the brick plant previously mentioned, showed a steep drop in levels probably relating to a substantial decrease in production at this plant, throughout the year. Considering similar drops in production at the steel industries, improvements in fluoride levels in the industrial area would be expected. However, no change in levels was observed except for a slight increase at the worst stations from 1981 levels which had been affected by the four month long Stelco strike.

5. DISCUSSION

The main pollution problem in Hamilton, apart from heavy fallout in the industrial area, is short-term pollution buildups during the spring and fall due to the presence of temperature inversions. During 1982, industrial production in Hamilton was substantially reduced compared to previous years due to the economic recession. Many smaller plants were shut down and larger ones were operating at as low as half capacity. As a result, industrial pollution emissions were down substantially. Despite this fact, there were thirteen incidents of elevated pollutant concentrations where the Air Pollution Index reached the advisory level of 32. This represents more incidents than in most past years when industrial emissions were higher. This indicates that once production returns to normal, these pollution buildups will recur for some time to come even with further improvements in pollution controls. The city's unique topography simply makes it very susceptible to inversions during which times pollution buildups are seemingly unavoidable.

Although industrial emissions were substantially reduced in 1982, data indicated that the industrial area was still a major source of airborne dust. The reductions in average pollutant concentrations at the North Park station during a year of substantially reduced emissions indicate that overall air quality improvements through further industrial abatement might still be achieved to some degree. However, the remaining pollution sources are difficult to control and in some cases control technology does not exist. Work is ongoing in attempts to better control these sources through existing Control Orders. As well, other pollution sources on which no emphasis has yet been placed may also require control wherever possible. These sources can be both industrial and non-industrial in nature, such as blowoff from unpaved areas, excavation, construction, demolition, road traffic, stock piles and other non-stack industrial emissions.

6. SPECIAL STUDIES

McMaster University has completed its three year epidemiological study which related air quality data to the respiratory health of 3000 Hamilton school children. The study also evaluated many other factors such as direct and indirect smoking, and other indoor environmental factors. Preliminary results clearly indicated that the children's respiratory health was most affected by smoking in the home particularly by the mother. Passive exposure to tobacco smoke in the home increases the risk that a child will develop respiratory ill health and will experience decreased pulmonary function. Compared to the effects of smoking by others in the home, effects associated with ambient air pollution were minor[1].

In 1983, the Upper Ottawa Landfill Site Health Study Committee concluded from air sampling tests, that concentrations of organic compounds decrease dramatically with distance from the vents and are comparable to background levels of the same chemicals at other selected locations in Hamilton.

The results of these chemical analyses indicated that at the present time, exposure to chemicals that endanger health is not significantly greater in the residential areas adjacent to the landfill than elsewhere in Hamilton.[2]

Nevertheless, the committee still recommended that a gas burning system be installed to alleviate any remaining concerns and to eliminate potential odours.

[1]A.T. Kerigan et al, "The Hamilton Study: The Effect of Environmental Factors on the Respiratory Health of School Children", (McMaster University, Hamilton Ont.), abstract.

[2]Upper Ottawa Landfill. Study Committee, "Interim Report on the Investigation of the Upper Ottawa Landfill Site", p. II-III.

In May and June 1982, stack sampling of the SWARU incinerator revealed trace amounts of the chemical families of dioxins and furans in the emissions leaving the stack. Preliminary dispersion calculations indicated that maximum ground level concentrations would exceed a newly formulated provincial guideline for these substances. Since the guideline was based on long term health effects, the incinerator was ordered to cut operations by 20% by operating only four days a week (until the initial test results could be confirmed under actual production conditions). Committees have subsequently been formed in the Ministry to determine further courses of action.

As an item of interest, the three month transit strike (June 11 to Sept. 11) had little discernible effect on air quality although suspended particulate concentrations were somewhat lower at several locations near major bus routes, such as Hughson/Hunter (downtown), Westdale Library, Cathedral Girls High School and the Mountain Police Station. However, other stations not close to bus routes such as Chatham/Frid and Cumberland Ave. also showed lower levels and most other stations showed little or no change.

Acknowledgment

We would like to thank Mr. Stephen A. Toplack of the Urban Air Environment Group at McMaster University for providing their suspended particulate data.

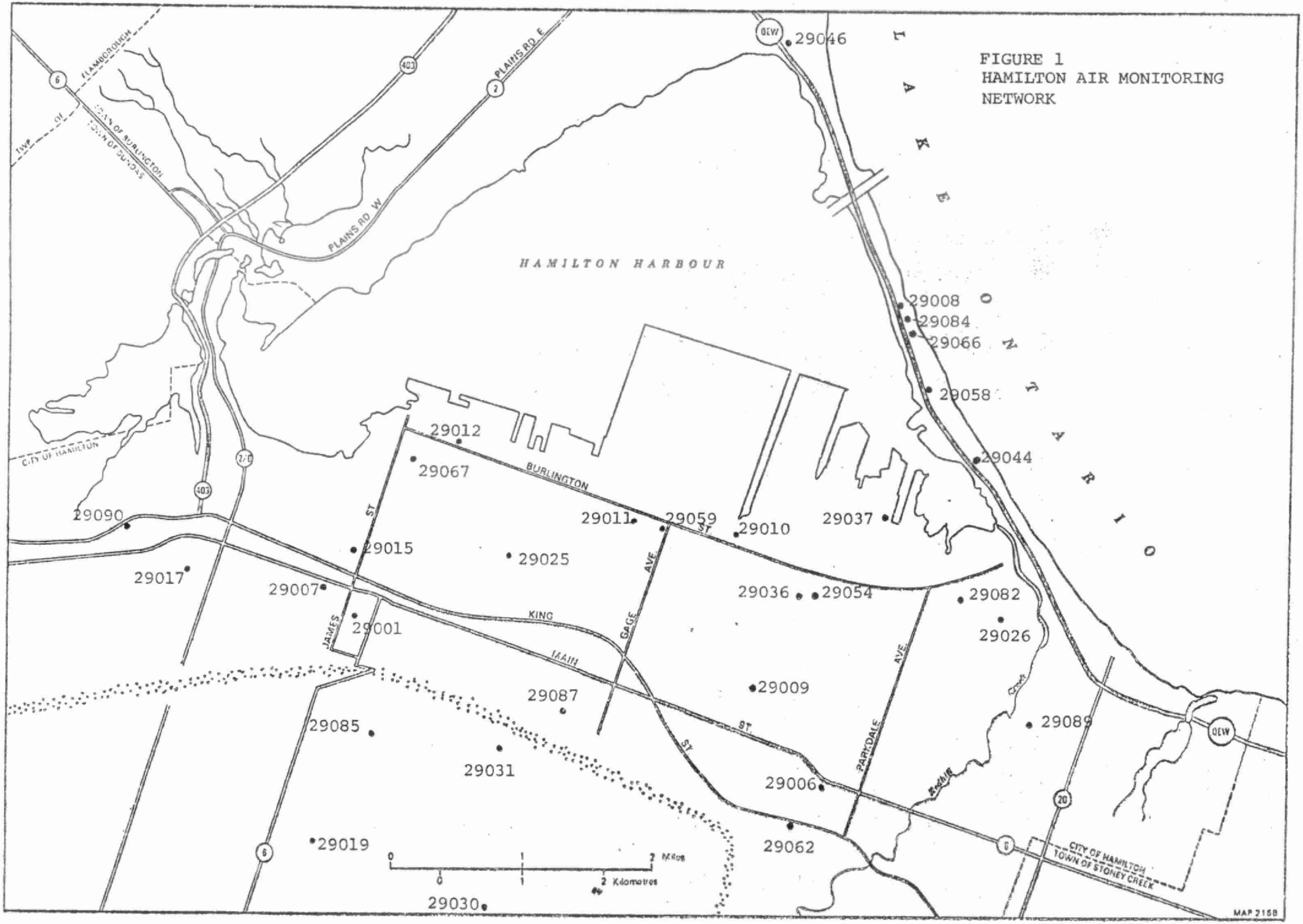
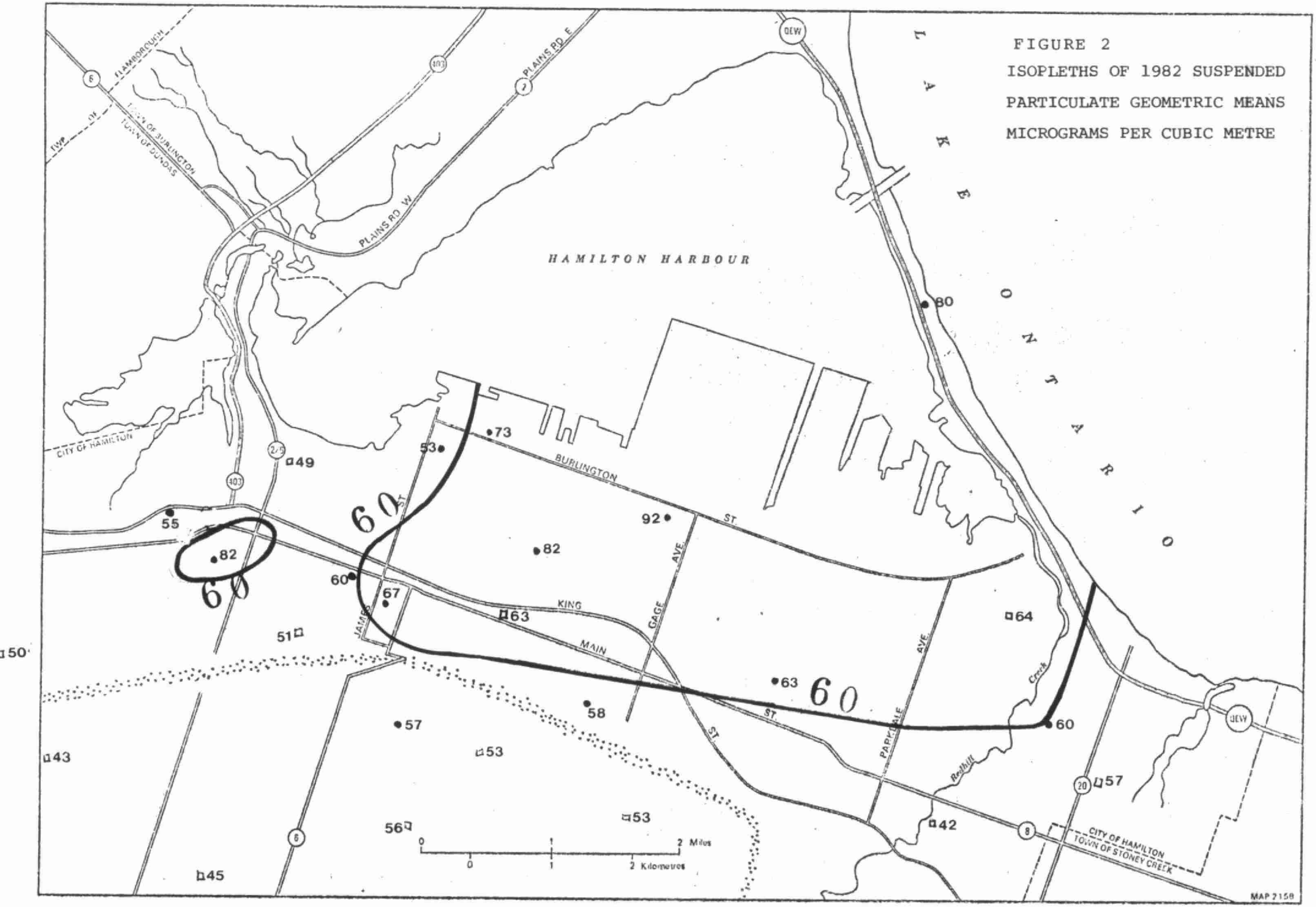


FIGURE 1
HAMILTON AIR MONITORING
NETWORK

FIGURE 2
ISOPLETHS OF 1982 SUSPENDED PARTICULATE GEOMETRIC MEANS MICROGRAMS PER CUBIC METRE



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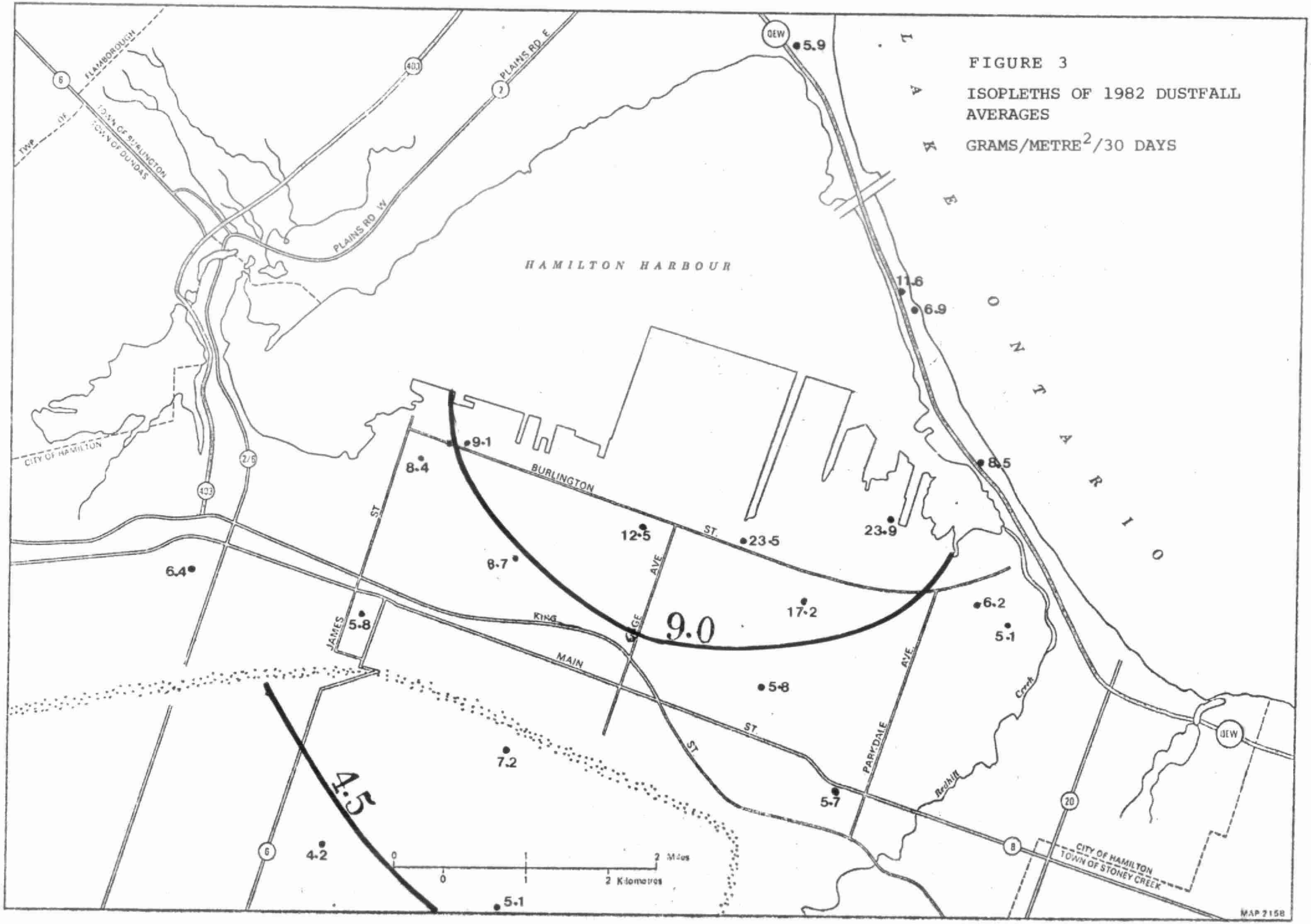
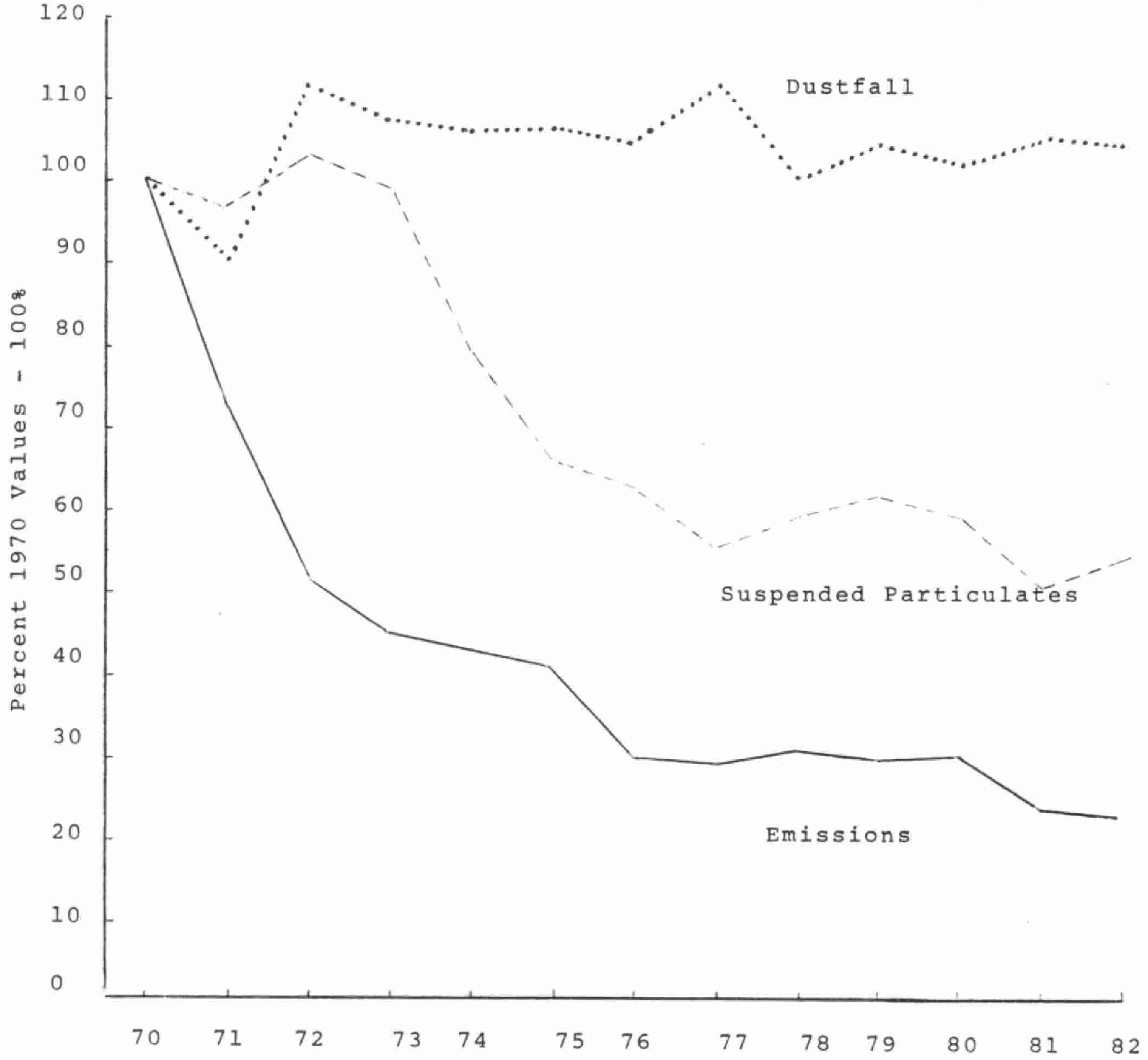


FIGURE 3
ISOPLETHS OF 1982 DUSTFALL AVERAGES
GRAMS/METRE^2/30 DAYS
HAMILTON HARBOUR
LAKE ONTARIO
9.0
4.5
5.9
11.6
6.9
8.5
9.1
8.4
12.5
23.5
23.9
8.7
6.4
17.2
6.2
5.8
5.1
5.8
7.2
5.7
4.2
5.1
BURLINGTON ST.
KING
MAIN ST.
GAGE AVE
JAMES ST
PARKDALE AVE.
PLAINS RD W
PLAINS RD E
CITY OF HAMILTON
TOWN OF STONEY CREEK
QEW
MAP 2158

FIGURE 4

Particulate Trends vs Estimated Emissions



Suspended Particulate (7 Stations) - ug/m^3

131	127	135	130	104	86	83	73	77	81	77	67	72

Dustfall (17 Stations)-g/m^2/30 days

9.4	8.5	10.4	10.1	9.9	10.0	9.8	10.4	9.4	9.8	9.6	9.9	9.8

Institutional & Industrial Emissions - Million lbs/year

56	41	29	25	24	23	17	16	17.5	16	16	13	12

Yearly Trends of Pollutants

FIGURE 5
Sulphur Dioxide

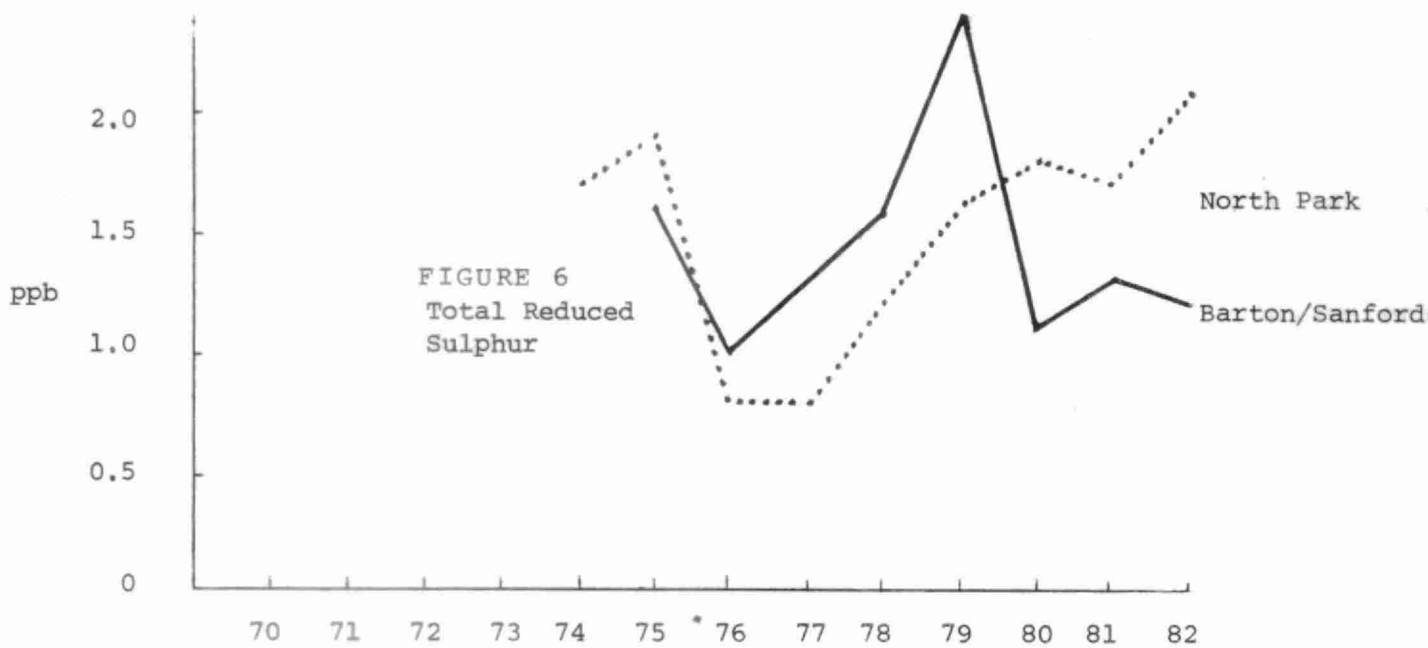


FIGURE 6
Total Reduced
Sulphur

Yearly Trends of Pollutants

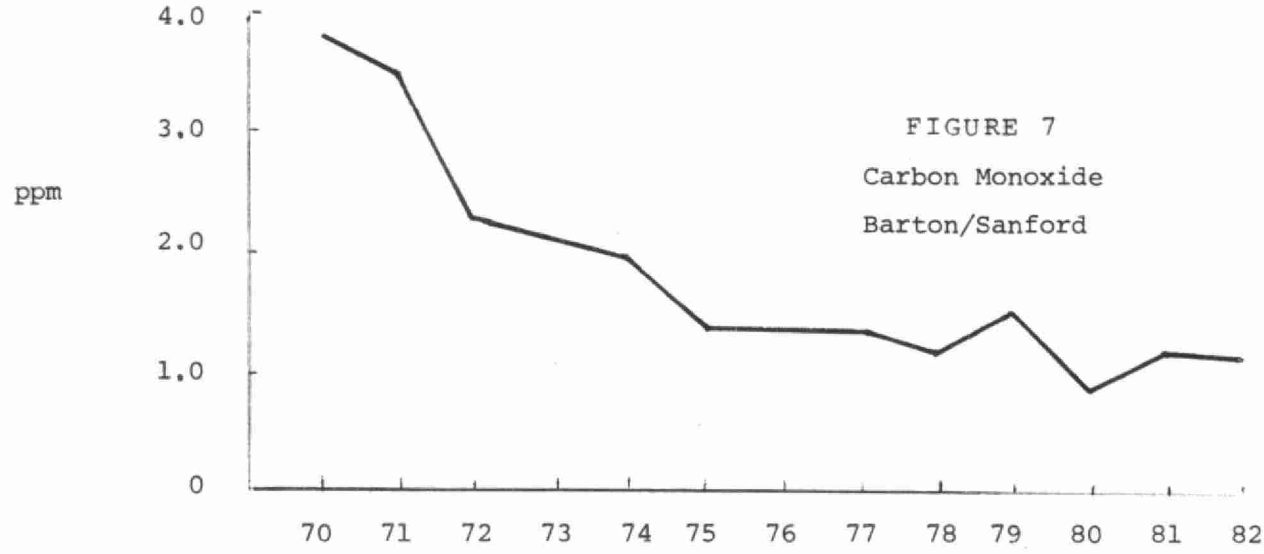


FIGURE 7
Carbon Monoxide
Barton/Sanford

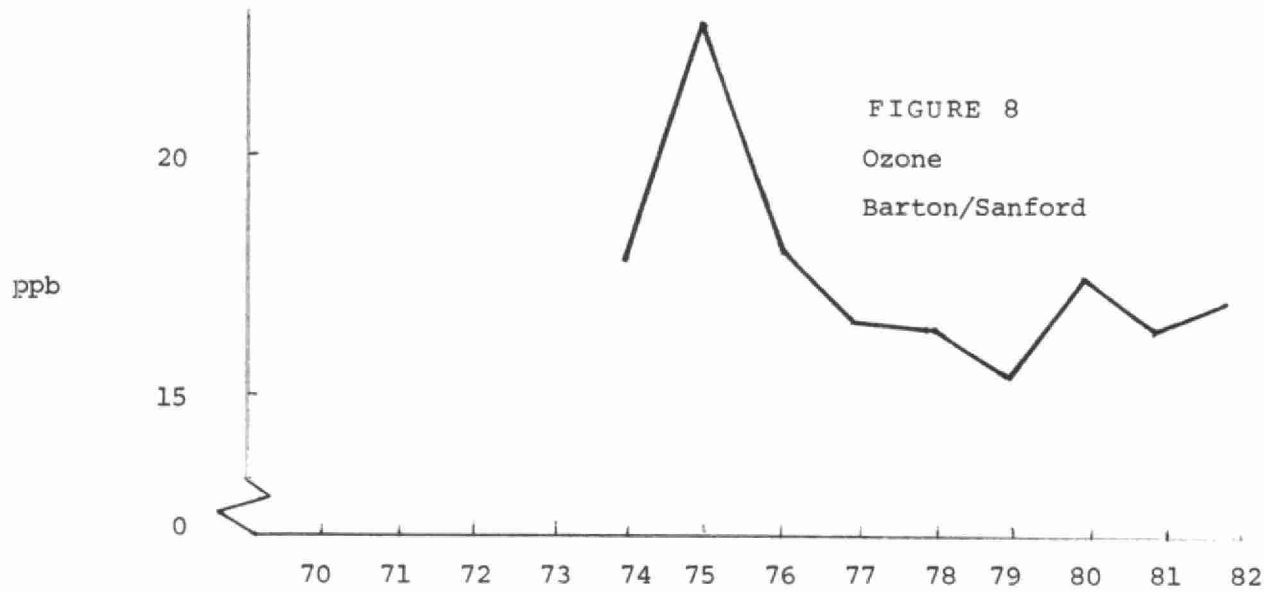


FIGURE 8
Ozone
Barton/Sanford

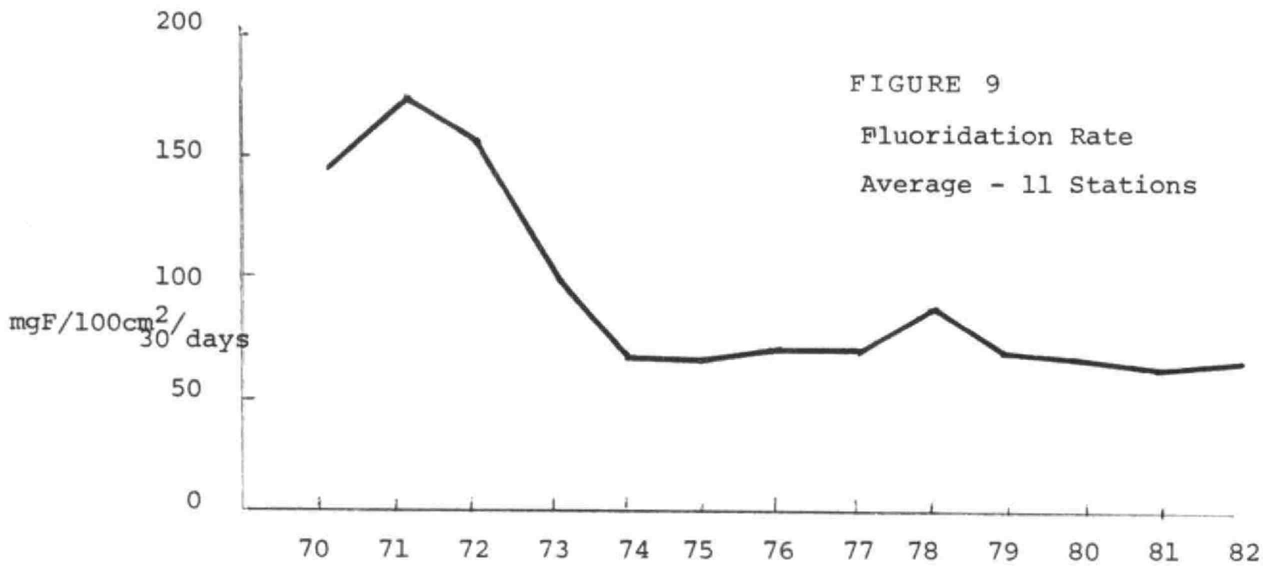


FIGURE 9
Fluoridation Rate
Average - 11 Stations

Yearly Trends of Pollutants

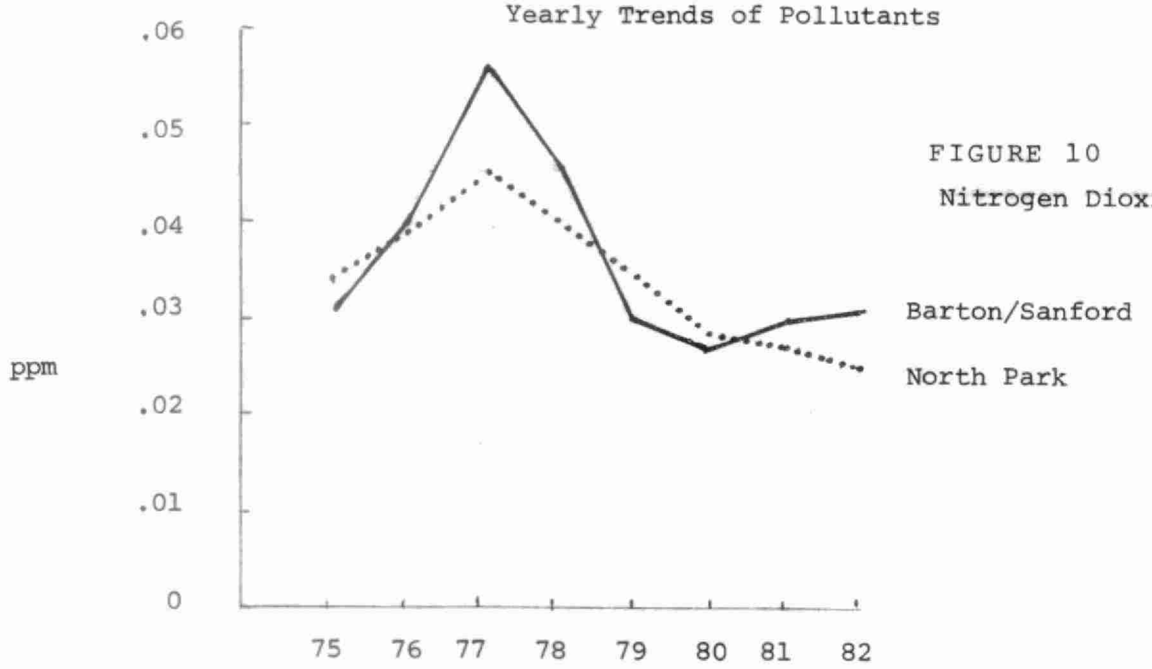


FIGURE 10
Nitrogen Dioxide

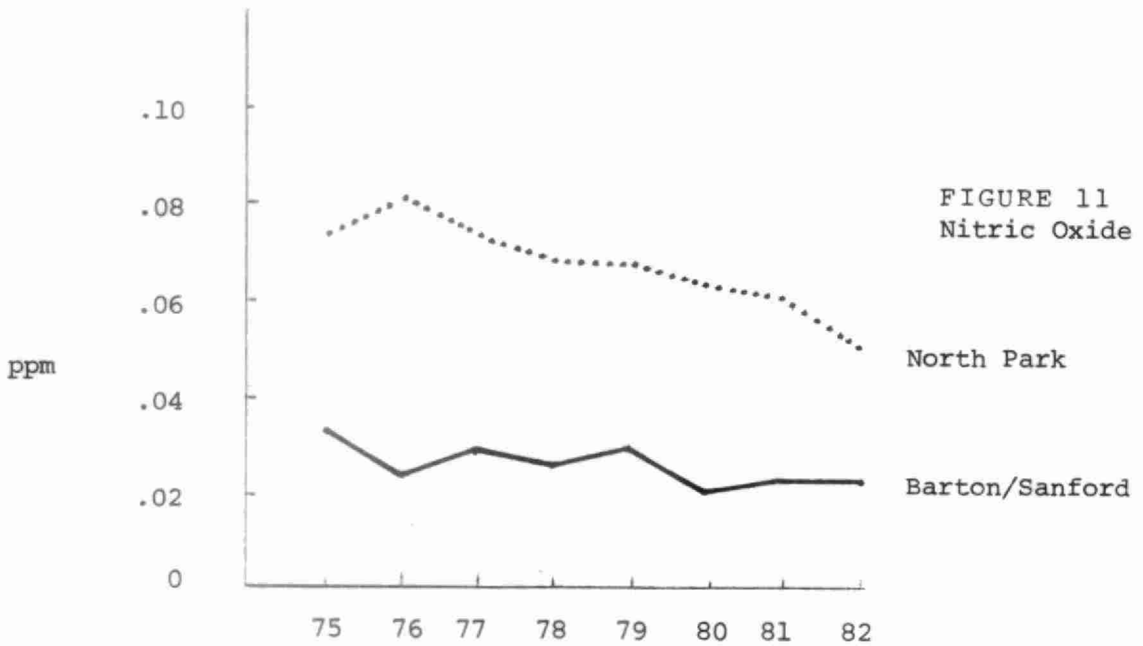


FIGURE 11
Nitric Oxide

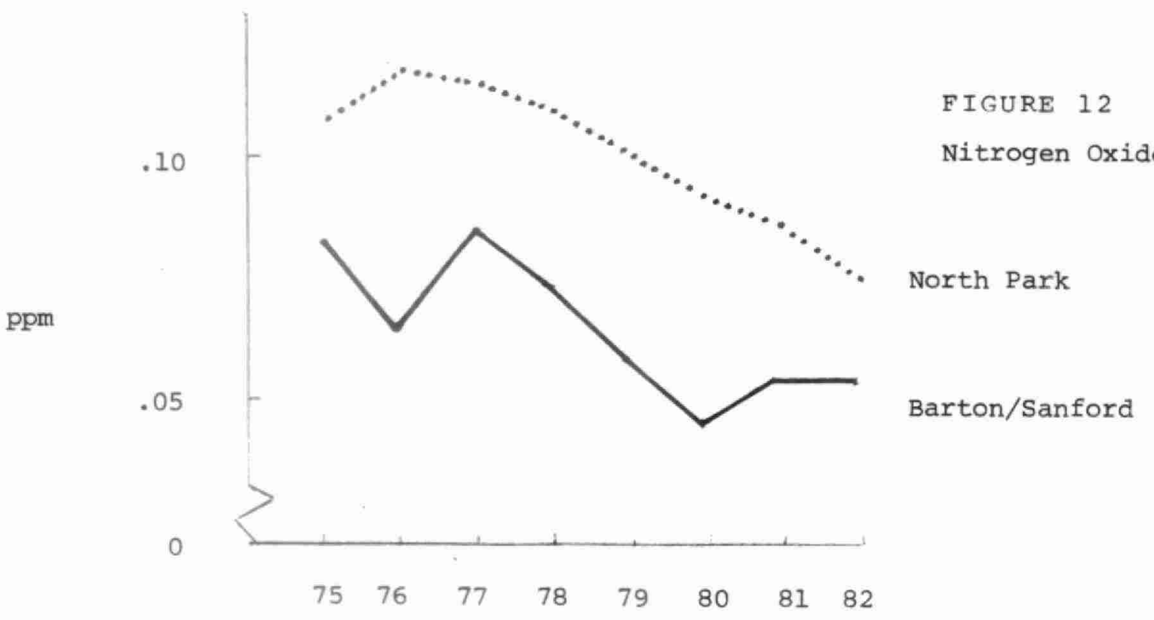


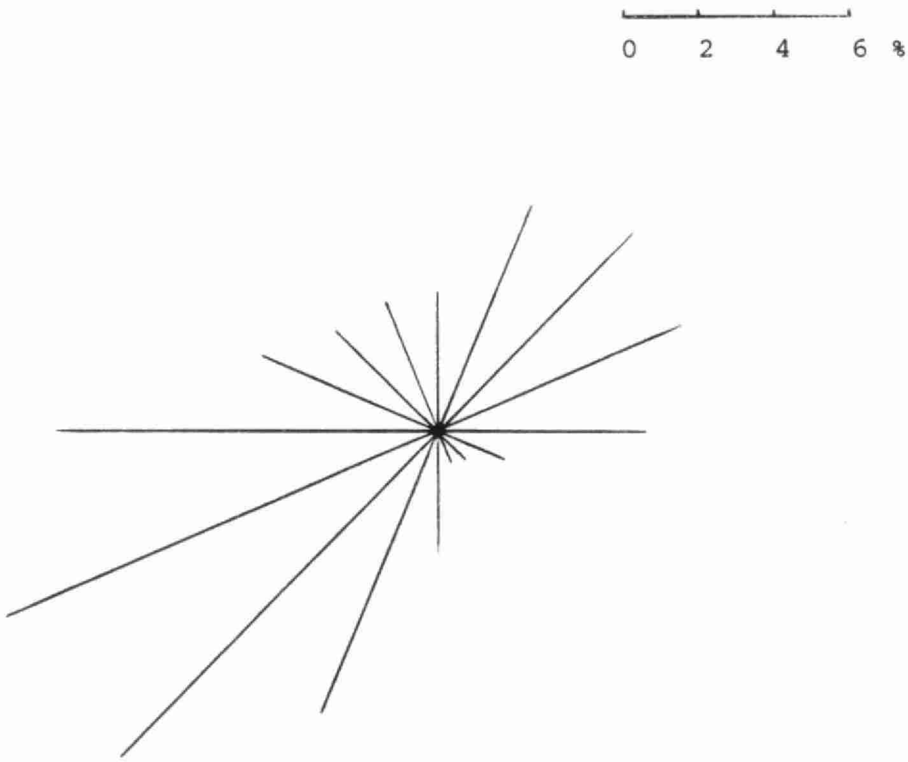
FIGURE 12
Nitrogen Oxides

FIGURE 13

Wind Frequency Rose - 1982

Woodward/Brampton - Hamilton

33 Ft. Level



Unit - %

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM
4	6	7	7	6	2	1	1	3	8	12	12	10	5	4	4	8

POLLUTION ROSES - SUSPENDED PARTICULATES - 1982

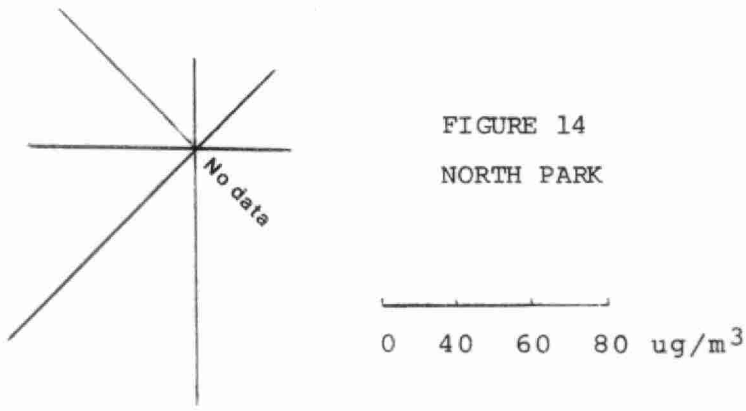


FIGURE 14

NORTH PARK

Unit - ug/m^3

N	NE	E	SE	S	SW	W	NW
47^{4}	61^{32}	50^{8}	-	136^{9}	140^{59}	89^{40}	103^{4}

Exponents refer to number of samples. Means are arithmetic.

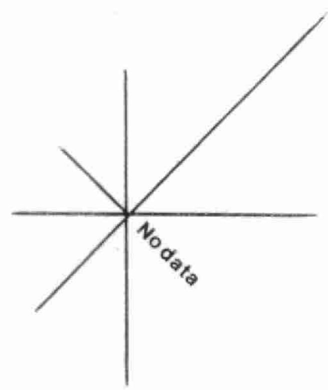


FIGURE 15

BARTON/SANFORD

Unit - ug/m^3

N	NE	E	SE	S	SW	W	NW
77^{3}	151^{31}	102^{9}	-	90^{9}	73^{61}	64^{41}	52^{4}

Pollution Roses - Soiling Index - 1982

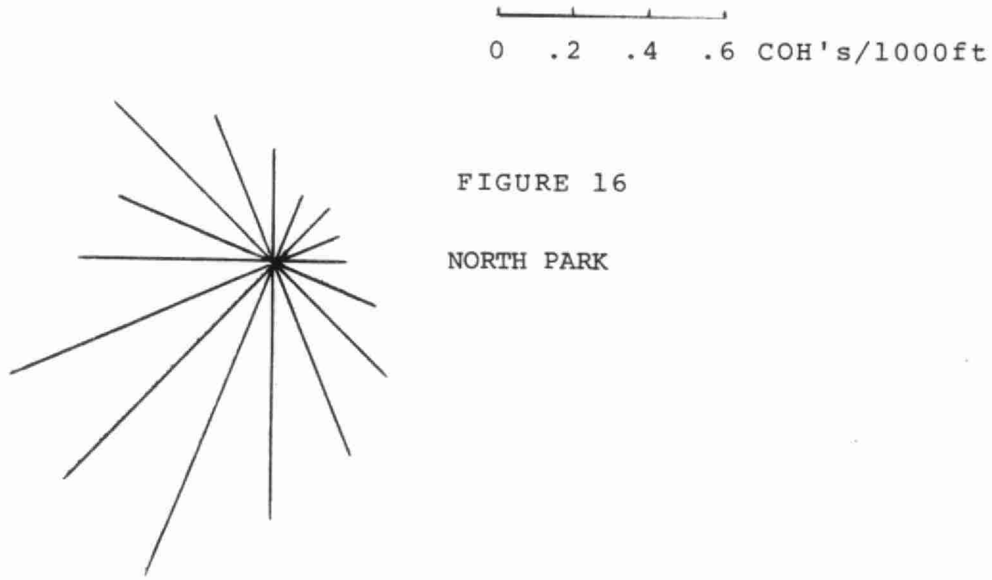


FIGURE 16

NORTH PARK

Unit - .01 COH's/1000 Ft.

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
30	19	20	18	19	30	42	54	67	89	80	76	51	44	60	42

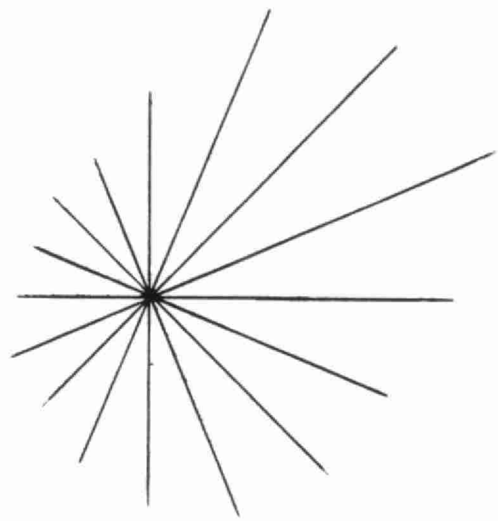


FIGURE 17

BARTON/SANFORD

Unit -.01 COH's/1000 Ft.

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
54	82	93	99	80	68	67	62	55	48	41	40	35	33	36	39

Pollution Roses - Sulphur Dioxide - 1982

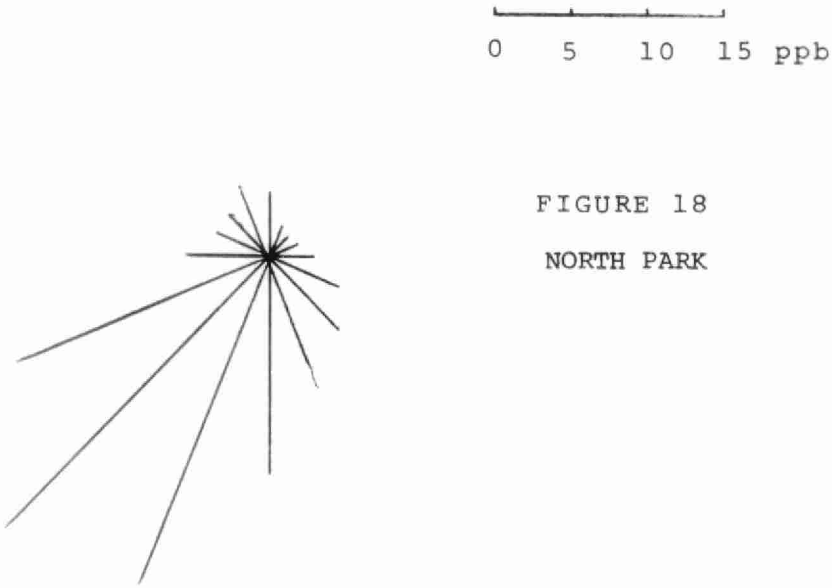


FIGURE 18

NORTH PARK

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
4	2	2	2	3	5	7	9	14	23	25	18	6	4	4	5

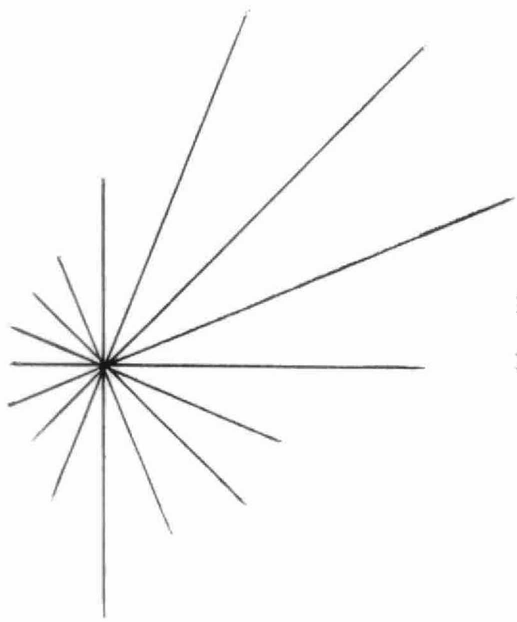


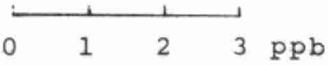
FIGURE 19

BARTON/SANFORD

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
12	25	30	29	21	13	13	12	17	10	7	7	6	7	7	8

Pollution Roses - Total Reduced Sulphur - 1982



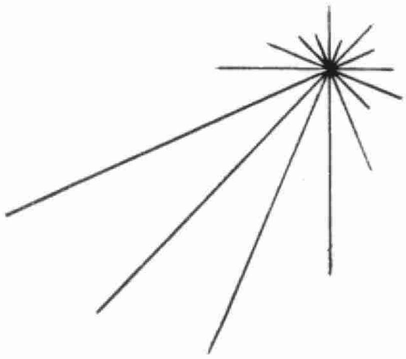


FIGURE 20

NORTH PARK

Unit - .1 ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
8	4	8	6	8	10	7	14	27	40	44	47	15	9	6	5

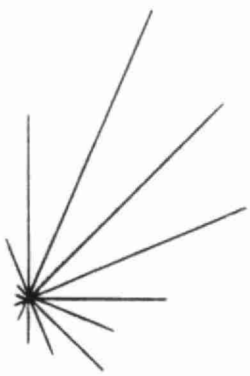


FIGURE 21

BARTON/SANFORD

Unit - .1 ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
24	41	36	31	18	12	14	8	6	3	1	2	1	1	2	8

Pollution Roses - Nitrogen Dioxide - 1982

0 .01 .02 .03 ppm

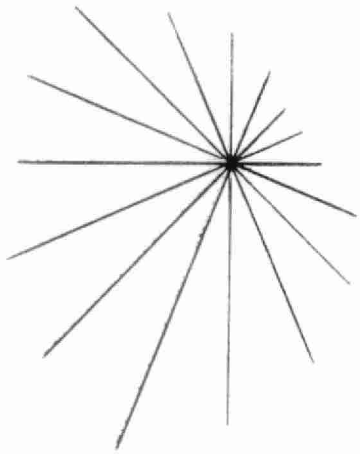


FIGURE 22

NORTH PARK

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
17	13	10	10	12	18	22	28	34	40	35	32	28	29	29	21

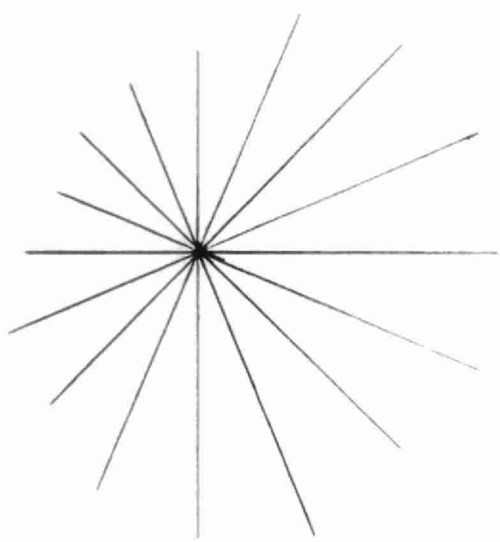


FIGURE 23

BARTON/SANFORD

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
26	34	38	40	39	40	37	40	38	34	28	27	23	20	22	24

Pollution Roses - Nitric Oxide - 1982

0 .02 .04 .06 ppm

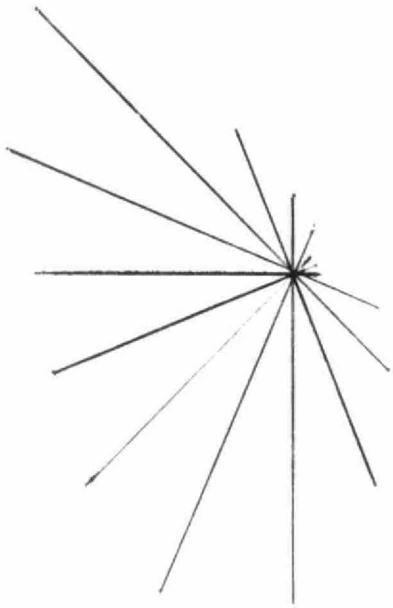


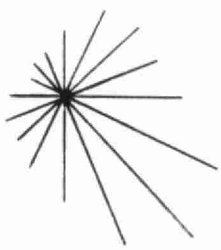
FIGURE 24

NORTH PARK

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
21	15	6	6	7	25	36	60	87	92	78	69	69	82	97	41

FIGURE 25



BARTON/SANFORD

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	W MW	NW	NNW
17	25	26	25	31	45	50	42	28	21	17	17	14	9	12	13

Pollution Roses - Total Nitrogen Oxides - 1982

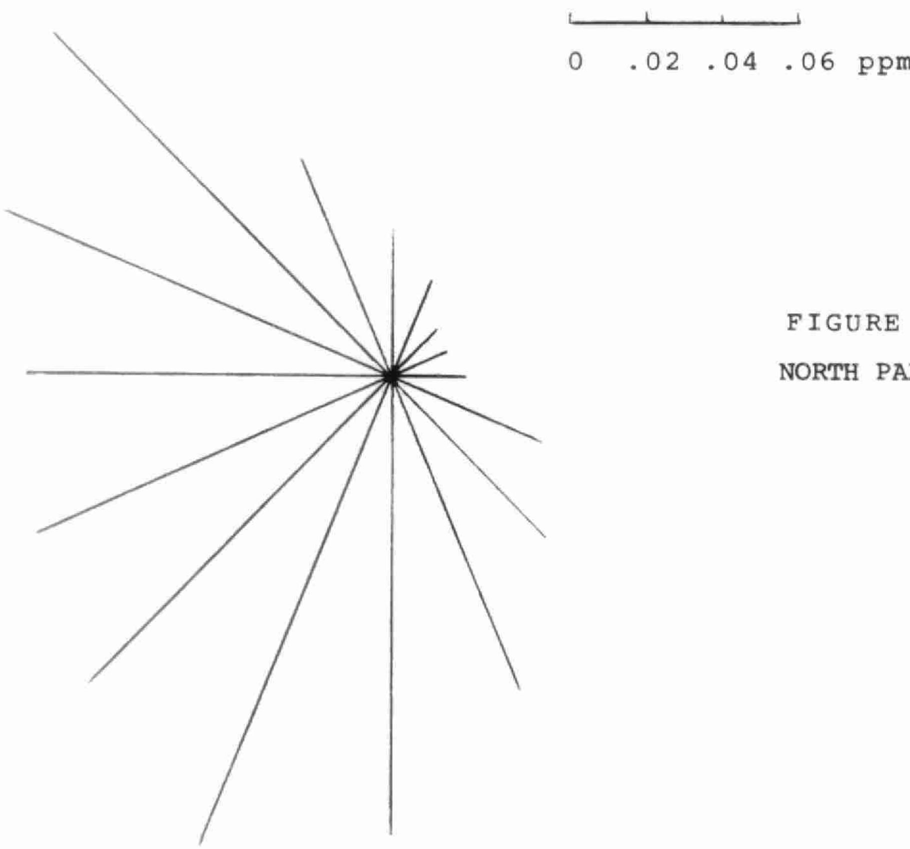


FIGURE 26
NORTH PARK

Unit-ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
38	27	16	16	19	43	58	88	120	132	113	102	97	111	126	62

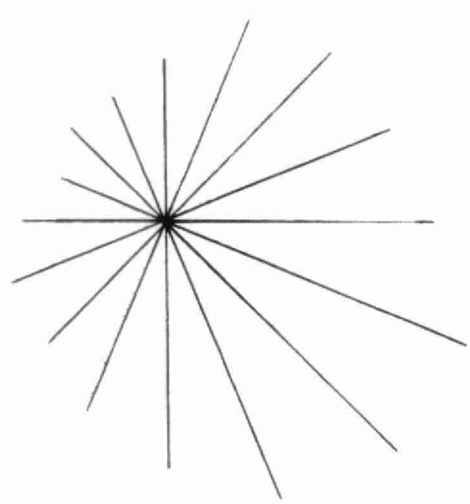


FIGURE 27
BARTON/SANFORD

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
42	57	63	65	70	85	85	80	65	54	45	44	37	29	34	35

Pollution Roses - 1982

Carbon Monoxide

0 .5 1.0 1.5 ppm

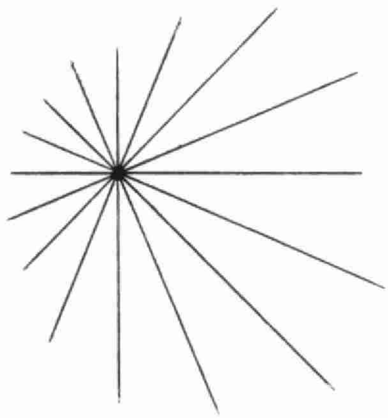


FIGURE 28

BARTON/SANFORD

Unit .1 ppm

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
8	11	15	17	16	19	20	17	15	12	9	8	7	7	7	8

Ozone

0 5 10 15 ppb

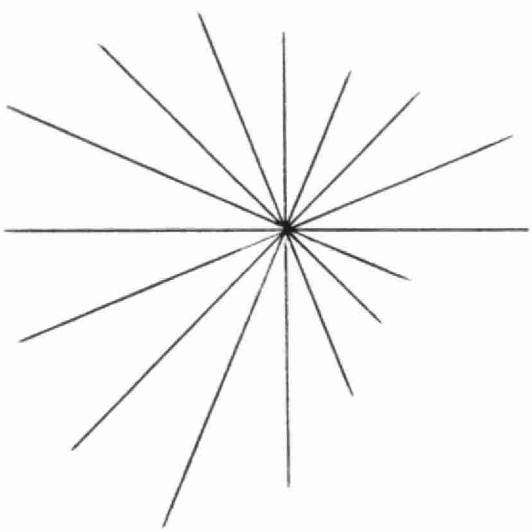


FIGURE 29

BARTON/SANFORD

Unit .1 ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
129	113	127	162	160	88	88	119	171	212	204	192	187	201	175	154

TABLE 1

AIR POLLUTION INDEX - 1982

OCCASIONS WHEN 32 OR ABOVE

	Date	Maximum	No. of Hours≥32
1.	February 2-3	36	17
2.	March 30-31	34	7
3.	April 16-17	36	19
4.	May 6-7	34	13
5.	May 12-13	36	29
6.	May 29	33	7
7.	July 14	32	3
8.	September 13-14	34	21
9.	October 6-7	34	25
10.	October 27	34	21
11.	November 18	32	1
12.	November 20	33	7
13.	December 1-2	39	33

TABLE 2a

SUSPENDED PARTICULATES - 1982

UNIT - MICROGRAMS PER CUBIC METER

ONTARIO OBJECTIVES: 24 hour - 120
1-year Geo. Mean - 60

	No. of Samples	Geometric Mean 1982	1981	1980	Maximum	%of Samples Above 120
29001 - Hughson/Hunter	54	67	63	71	250	18
29007 - City Hall	58	60	57	59	251	18
29008 - North Park	338	80	72	95	323	23
29009 - Kenilworth	58	63	64	67	200	14
29011 - Burlington/Leeds	58	92	101	124	370	33
29012 - Burlington/Wellington	59	73	63	73	201	15
29017 - Chatham/Frid	59	82	75	84	329	27
29025 - Barton/Sanford	335	82	72	88	395	22
29067 - 450 Hughson St. N.	53	53	56	65	160	8
29085 - Mountain Police Station	50	57	55	56	205	12
29087 - Cumberland	58	58	64	65	211	12
29089 - Barton/Nash	55	60	59	70^{9}	185	11
29090 - Westdale Library	48	55	59	67^{5}	179	6

Exponents refer to number of months of sampling (when less than 12)

TABLE 2b

MCMASTER UNIVERSITY SAMPLING - 1982

SUSPENDED PARTICULATES

MICROGRAMS PER CUBIC METER

ONTARIO OBJECTIVES: 24-hour average - 120
1-year Geo. Mean - 60

LOCATION	No. of Samples	Geometric Mean 1982	1981	1980	Maximum	% of Samples Over 120
San Diego Court	55	43	39	35	144	4
Upper Ottawa/Mohawk	57	39	37	36	186	2
Aberdeen/Undermount	56	51	41	45	175	9
Whitney/Rifle Range	59	50	43	44	164	5
Pottruff/Queenston	58	42	40	39	159	2
McElroy/Upper Wellington	48	56	51	43	176	9
Queensdale/Green Meadow	50	53	49	43	130	2
Upper Wentworth/Queensdale	61	53	40	47	158	8
Main/Wentworth	53	63	61	62	168	11
Westmount	56	45	41	36	191	7
Bishopgate/Ranchdale	57	42	43	49	142	5
Dundurn Castle	59	49	49	44	125	2
Centennial Pkwy./Violet Drive	55	57	58	60	140	7
Woodward/Brampton	51	64	76	66	132	6

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	CADMIUM (Criterion: 2.0 (24 Hours))			CHROMIUM			IRON			LEAD (Criterion: 5.0 (24 Hours))			MANGANESE		
	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.
29001															
1979	48	.001	.009	48	.007	.059	48	1.9	19.7	48	0.5	1.8	48	.10	1.08
1980	58	.001	.009	58	.003	.052	58	1.4	10.9	58	0.4	1.7	58	.08	3.24
1981	59	.001	.006	59	.005	.140	59	1.5	21.6	59	0.4	1.2	57	.07	.86
1982	55	.001	.008	55	.004	.039	52	1.2	17.8	52	0.3	1.1	55	.08	.62
29008															
1979	215	.000	.004	189	.012	.064	207	3.9	24.7	311	0.7	3.0	207	.23	1.39
1980	313	.001	.018	345	.011	.089	343	4.3	35.3	347	0.6	1.9	346	.29	2.32
1981	324	.001	.009	323	.008	.097	324	2.8	22.3	326	0.6	2.3	325	.17	1.50
1982	330	.001	.005	327	.006	.091	309	2.7	16.3	338	0.4	1.8	330	.15	.89
29011															
1979	33	.002	.021	33	.022	.092	33	5.4	30.8	33	0.6	2.2	33	.39	1.72
1980	57	.001	.012	57	.025	.080	57	5.5	30.6	57	0.6	1.8	57	.47	1.58
1981	69	.002	.011	69	.021	.420	69	4.5	31.2	69	0.4	1.3	69	.32	1.85
1982	57	.001	.016	57	.014	.078	57	3.8	42.0	54	0.3	1.7	57	.21	1.54
29012															
1979	43	.001	.003	43	.005	.030	43	1.6	7.8	43	0.3	0.9	44	.11	.54
1980	54	.001	.005	54	.007	.044	54	2.0	10.1	54	0.3	0.7	54	.15	.79
1981	68	.001	.007	68	.006	.030	68	1.4	8.7	68	0.2	0.9	68	.11	.67
1982	59	.001	.012	58	.008	.051	58	1.7	11.5	55	0.3	1.1	59	.11	.55

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Criterion: 2.0(24 Hours)

Criterion: 5.0(24 Hours)

Station and Year	CADMIUM # of Samples	CADMIUM Geo. Mean	CADMIUM Max.	CHROMIUM # of Samples	CHROMIUM Geo. Mean	CHROMIUM Max.	IRON # of Samples	IRON Geo. Mean	IRON Max.	LEAD # of Samples	LEAD Geo. Mean	LEAD Max.	MANGANESE # of Samples	MANGANESE Geo. Mean	MANGANESE Max.
29017															
1979	58	.001	.007	58	.004	.066	58	2.3	19.7	58	0.4	2.7	57	.11	1.52
1980	55	.001	.005	55	.006	.057	55	2.2	9.6	55	0.3	1.5	55	.10	1.84
1981	57	.001	.007	57	.005	.086	57	1.9	28.1	57	0.3	2.6	57	.09	2.05
1982	59	.001	.009	59	.005	.047	52	2.1	19.5	58	0.3	3.0	59	.09	.76
29025															
1979	181	.001	.039	182	.009	.208	190	2.9	33.7	309	0.6	4.2	181	.18	2.67
1980	327	.001	.032	304	.009	.169	291	2.6	17.2	328	0.5	1.9	327	.18	9.77
1981	317	.001	.023	317	.009	.103	317	2.3	32.9	317	0.6	3.1	316	.15	1.62
1982	325	.001	.026	325	.008	.093	296	2.6	27.9	301	0.4	2.3	325	.14	1.22
29067															
1979	56	.001	.007	49	.008	.046	56	1.7	8.6	57	0.3	1.2	56	.11	1.07
1980	55	.001	.038	55	.007	.054	55	1.8	14.8	55	0.3	1.2	55	.14	1.43
1981	58	.001	.008	58	.006	.040	58	2.0	9.7	58	0.3	1.5	58	.08	.85
1982	45	.001	.008	45	.007	.088	43	1.4	8.5	43	0.2	1.2	45	.09	.84
29085															
1979	30	.001	.003	30	.003	.071	30	1.3	8.7	30	0.3	0.9	30	.06	.46
1980	57	.001	.006	59	.003	.109	59	1.1	12.6	59	0.3	0.9	59	.05	.75
1981	55	.001	.004	54	.003	.057	55	1.2	14.6	55	0.3	1.3	54	.07	1.01
1982	49	.001	.004	45	.003	.033	46	1.1	14.0	47	0.3	1.1	49	.06	.59

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	NICKEL Criterion: 2.0(24 Hours)			VANADIUM Criterion: 2.0(24 Hours)			NITRATE			SULPHATE		
	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.
29001												
1979	48	.007	.040	48	.01	.08	57	4.7	19.8	57	11.9	27.6
1980	58	.004	.036	58	.01	.04	43	3.6	9.9	43	10.3	23.5
1981	59	.002	.038	59	.01	.05	59	4.1	15.2	59	9.1	24.2
1982	55	.002	.021	55	.01	.03	53	4.1	12.1	53	9.6	39.3
29008												
1979	207	.007	.069	207	.01	.04	239	4.0	21.7	240	13.6	49.9
1980	311	.006	.048	342	.01	.04	343	4.0	20.9	343	14.5	43.1
1981	325	.005	.048	325	.01	.05	326	3.6	20.8	326	10.8	43.6
1982	330	.003	.055	331	.01	.04	334	4.0	16.4	334	11.4	38.5
29011												
1979	33	.007	.061	33	.01	.06	58	3.7	13.8	58	14.0	30.9
1980	57	.011	.030	57	.01	.04	56	4.1	12.7	56	14.9	33.0
1981	69	.007	.028	69	.01	.05	69	3.8	14.1	69	11.5	34.1
1982	57	.005	.042	57	.01	.05	56	4.0	13.9	57	11.2	53.4
29012												
1979	43	.005	.041	43	.00	.08	54	4.4	23.4	54	11.3	32.4
1980	57	.004	.032	54	.01	.06	52	3.6	13.7	51	10.9	22.2
1981	68	.003	.026	68	.01	.03	68	3.3	18.8	68	8.7	26.4
1982	59	.004	.026	59	.01	.04	59	4.6	15.8	59	9.1	39.2

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	NICKEL Criterion: 2.0(24 Hours)			VANADIUM Criterion: 2.0(24 Hours)			NITRATE			SULPHATE		
	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.
29017												
1979	58	.006	.078	58	.01	.13	49	4.2	23.6	49	12.1	34.5
1980	55	.007	.045	55	.01	.13	55	3.7	15.6	55	12.0	24.3
1981	57	.004	.055	57	.01	.08	57	4.0	17.9	57	10.3	28.6
1982	59	.006	.032	59	.01	.04	59	4.3	16.0	59	10.2	38.7
29025												
1979	181	.010	.164	181	.01	.09	281	4.0	25.0	281	13.6	40.4
1980	327	.010	.233	329	.01	.07	305	3.8	16.3	328	12.5	43.1
1981	317	.006	.051	317	.01	.08	317	3.3	25.0	317	9.5	41.0
1982	325	.006	.068	325	.01	.08	337	3.7	20.5	337	9.6	59.3
29067												
1979	40	.005	.077	56	.00	.02						
1980	55	.007	.031	55	.01	.03						
1981	58	.002	.053	58	.01	.03						
1982	45	.006	.023	45	.01	.04						
29085												
1979	30	.003	.017	28	.00	.02	21	3.9	14.2	21	10.5	18.5
1980	59	.003	.022	59	.01	.03	59	3.5	12.4	59	10.7	20.7
1981	55	.001	.023	53	.01	.03	55	3.7	14.2	55	9.3	27.6
1982	49	.002	.024	49	.00	.03	50	3.6	13.2	50	9.4	35.6
29087												
1979							21	4.0	12.5	21	11.9	24.1
1980							58	3.4	9.7	58	11.2	27.0
1981							58	3.3	11.9	58	9.2	24.4
1982							58	4.0	17.1	58	10.3	41.1

TABLE 3

SOILING INDEX - 1982

1-HOUR TELEMETERED INSTRUMENTS

UNITS - COH's per 1000 linear ft. of air

Ontario Objectives - 24-hour - 1.0
1-year - 0.5

	Annual Average 1982	1981	1980	1979	Maximum 24-hour	No. of Times Above Objective 24-hour
29008 - North Park	.51	.72	.72	.73	1.6	23
29025 - Barton/Sanford	.59	.58	.54	.63	1.8	41

TABLE 4

DUSTFALL 1982

UNITS - GRAMS/SQ. METRE/30 DAYS

Ontario Objectives - 1 month avg - 7.0
1 year ave - 4.5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average 1982	1981	1980
29001 Hughson/Hunter	-	3.4	10.3	5.8	9.5	7.6	6.7	5.2	2.3	4.3	6.4	1.9	5.8[11]	8.0[11]	6.5
29006 Queenston	13.2	3.3	9.5	5.9	6.3	6.7	6.2	3.8	4.4	3.0	2.4	3.4	5.7	6.6	6.4
29008 North Park	27.5	20.4	16.7	12.9	7.8	9.6	8.9	8.5	6.7	8.3	7.1	5.4	11.6	12.8	13.9
29009 Kenilworth	7.4	4.6	11.6	6.4	8.0	7.7	5.2	3.7	5.0	3.9	2.8	3.2	5.8	5.5	5.1
29010 Burlington/ Ottawa	14.8	19.0	36.9	24.8	31.3	30.1	19.9	20.7	25.7	26.1	22.3	10.8	23.5	25.9	19.5[11]
29011 Burlington/ Leeds	14.0	9.7	19.5	7.5	18.6	15.4	12.2	12.6	12.4	12.2	9.3	6.9	12.5	13.2	14.8[11]
29012 Burlington/ Wellington	13.2	8.1	13.8	13.7	12.3	9.3	8.3	8.2	7.5	5.7	6.2	3.1	9.1	8.5	9.5
29017 Chatham/Frid	-	2.6	7.0	6.9	6.8	5.7	10.0	5.4	6.0	6.0	7.8	6.6	6.4[11]	11.1[11]	10.6
29019 Mohawk/Warren	5.3	1.7	5.6	3.8	6.7	8.6	4.5	2.6	4.1	2.5	3.3	1.2	4.2	3.8	3.5
29025 Barton/Sanford	12.0	3.7	10.6	8.4	17.4	4.2	9.1	14.6	9.7	5.0	6.4	2.9	8.7	8.7	9.0
29026 Woodward/ Brampton	-	1.0	7.0	6.1	5.7	10.7	3.2	6.2	5.5	3.2	4.2	3.8	5.1	7.2	5.8
29030 Camden/Mohawk	6.9	3.7	6.5	4.3	9.2	7.1	4.6	5.5	5.1	2.3	3.0	3.4	5.1	5.8	5.7
29031 Concession/ Upper Sherman	13.7	4.6	11.8	6.0	8.7	8.2	7.1	6.0	6.3	4.0	5.2	5.4	7.2	6.9	6.3

TABLE 4 (con'd)
DUSTFALL 1982

UNITS - GRAMS/SQ. METRE/30 DAYS

Ontario Objectives - 1 month avg - 7.0
1 year avg - 4.5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average 1982	1981	1980
29036 Roosevelt/ Beach Rd.	28.7	10.4	34.9	15.8	16.0	22.0	14.6	14.1	14.7	10.6	14.5	10.6	17.2	11.8[11]	10.9
29037 Strathearn	15.1	18.3	30.3	24.5	24.4	23.9	14.3	36.6	25.3	39.0	23.4	11.7	23.9	21.3	21.1
29044 Wark/ Beach Blvd.	8.9	7.3	11.5	9.3	8.7	10.1	9.7	8.5	7.7	6.0	6.4	8.3	8.5	8.2	9.6
29046 O.P.P. Bldg Burlington	9.8	3.2	19.5	4.0	4.0	-	-	5.6	3.9	2.2	5.1	2.0	5.9[10]	3.0[11]	4.2
29067 450 Hughson N.	22.1	5.9	12.5	5.2	10.0	8.0	5.4	-	6.6	5.1	4.7	6.5	8.4[11]	6.0	5.9
29082 Leaside Rd.	5.9	3.5	8.7	6.3	10.1	7.7	7.2	5.4	6.4	4.5	5.1	4.5	6.2	9.8[11]	7.2
29084 Rembe/ Beach Blvd.	10.1	6.5	7.8	5.9	5.8	10.5	7.4	7.0	13.0	4.6	5.6	4.9	6.9	8.1[10]	7.4[11]

- Underlined values are above objective

TABLE 5

SULPHUR DIOXIDE

UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .25
24-hour - .10
1-year - .02

		Annual Average	Maximum 1-hour	Maximum 24-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 24-hour
29008 - North Park	1982	.010	.17	.05	0	0
	1981	.014	.12	.07	0	0
	1980	.014	.13	.07	0	0
	1979	.012	.14	.08	0	0
29025 - Barton/ Sanford	1982	.014	.18	.05	0	0
	1981	.010	.14	.06	0	0
	1980	.013	.16	.06	0	0
	1979	.017	.25	.10	0	0

TABLE 6

TOTAL REDUCED SULPHUR

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 20 (Hydrogen Sulphide)

		Annual Average	Maximum	No. of Times Above Objective
29008 - North Park	1982	2.1	122	49
	1981	1.6	47	35
	1980	1.8	44	26
	1979	1.6	32	3
29025 - Barton/ Sanford	1982	1.2	111	32
	1981	1.3	83	46
	1980	0.9	61	26
	1979	2.4	144	75

TABLE 7

CARBON MONOXIDE

UNITS - PARTS PER MILLION

Ontario Objective: 1-hour - 30
8-hour - 13

		Annual Average	Maximum 1-hour	Maximum 8-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 8-hour
29025 - Barton/ Sanford	1982	1.1	10	5	0	0
	1981	1.2	15	8	0	0
	1980	0.9	10	4	0	0
	1979	1.5	14	9	0	0

TABLE 8

NITROGEN DIOXIDE

UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .20
24-hour - .10

		Annual Average	Maximum 1-hour	Maximum 24-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 24-hour
29008 - North Park	1982	.025	.10	.07	0	0
	1981	.027	.24	.08	3	0
	1980	.028	.15	.10	0	0
	1979	.034	.16	.10	0	0
29025 - Barton/ Sanford	1982	.031	.11	.08	0	0
	1981	.029	.15	.08	0	0
	1980	.027	.15	.06	0	0
	1979	.029	.12	.07	0	0

TABLE 9

NITRIC OXIDE

UNITS - PARTS PER MILLION

		Annual Average	Maximum 1-hour	Maximum 24-hour
29008 - North Park	1982	.051	.59	.19
	1981	.061	.67	.27
	1980	.065	.52	.16
	1979	.068	1.00	.23
29025 - Barton/ Sanford	1982	.024	.44	.16
	1981	.024	.83	.29
	1980	.021	.43	.13
	1979	.030	.78	.43

TABLE 10

NITROGEN OXIDES
(Sum of Nitrogen Dioxide and Nitric Oxide)

UNITS - PARTS PER MILLION

		Annual Average	Maximum 1-hour	Maximum 24-hour
29008 - North Park	1982	.076	.64	.24
	1981	.087	.73	.32
	1980	.093	.55	.21
	1979	.101	1.04	.30
29025 - Barton/ Sanford	1982	.054	.52	.23
	1981	.054	.95	.37
	1980	.046[10]	.34	.12
	1979	.059	.88	.50

TABLE 11

OZONE

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 80

		Annual Average	Maximum	No. of Times Above Objective
29025 - Barton/ Sanford	1982	16.9	88	4
	1981	16.3	89	15
	1980	17.4	107	24
	1979	15.3	112	32

TABLE 12

FLUORIDATION RATE - 1982

ALL VALUES IN MICROGRAMS/100 SQ.CM/30 DAYS

Ontario Criteria: April 15 to October 15 - 40
October 16 to April 14 - 80

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average 1982	1981	1980
29001 Hughson/Hunter	32	37	41	23	92	52	41	28	26	24	18	12	36	32[11]	31[11]
29008 North Park	161	158	88	98	27	50	101	87	59	59	84	56	86	76	99
29012 Burlington/ Wellington	33	58	46	18	52	36	33	29	21	34	20	17	33	28	35[11]
29017 Chatham/Frid	32	59	50	30	126	59	57	47	13	16	27	17	44	45	38
29025 Barton/Sanford	26	43	46	22	116	63	73	49	81	35	31	20	50	33	35
29026 Woodward/ Brampton	26	47	41	30	22	24	49	52	34	24	27	20	33	34	33
29054 Beach Rd./ Conrad	57	77	61	68	48	26	--	71	42	32	57	27	51[11]	67	55
29058 Q.E.W./Skyway	178	178	181	144	--	76	107	157	129	78	94	67	126[11]	110	135
29059 Burlington/ Gage	139	190	103	111	140	85	155	98	99	90	34	49	108	90	103
29062 Briarwood School/King St.E.	59	59	32	24	14	44	51	69	28	56	36	58	44	77	60
29066 Killarney/ Beach B.	111	131	98	87	11	35	68	63	39	44	63	50	67	56	70

-Underlined values are above objective